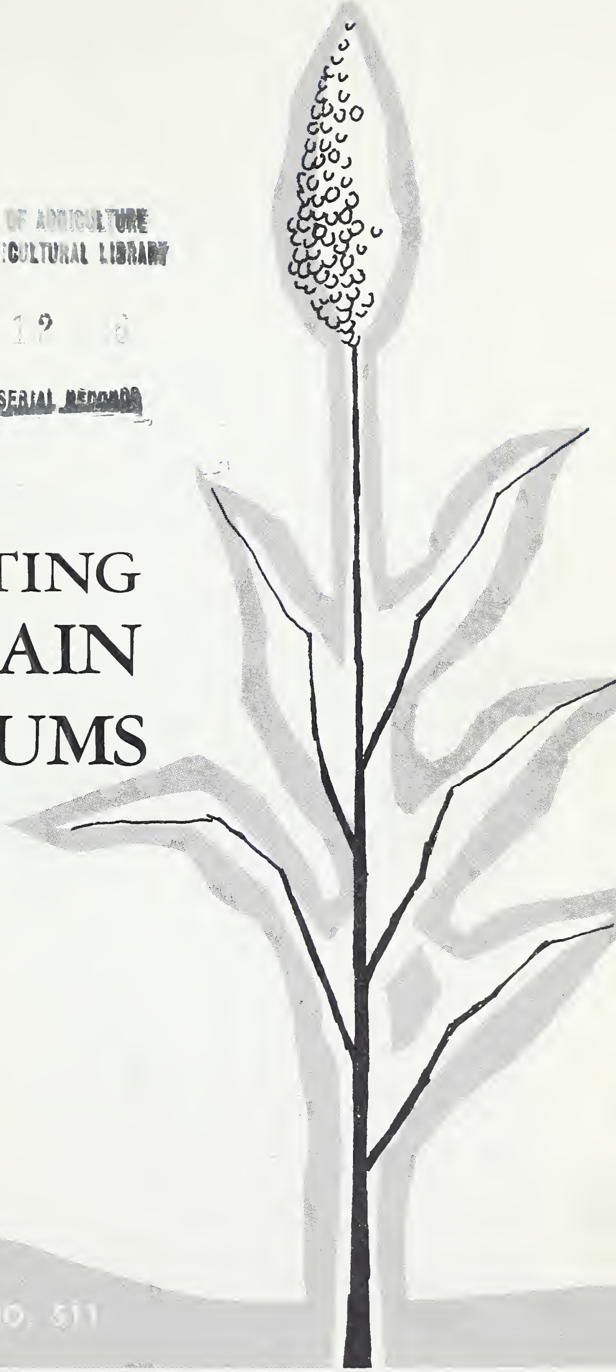
IRRIGATING GRAIN SORGHUMS



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Irrigation may greatly increase the value of rainfall for sorghum grain production. In areas where rainfall is not adequate for good yields, most of the moisture produces vegetative growth. To produce the first increment of grain, 8 to 11 inches of water are required. By the time grain development begins, rainfall may not be adequate to mature the crop. A well-timed irrigation in the southern Great Plains has resulted in more than 500 pounds of grain per acre-inch of water stored in the soil. In nonirrigated areas, yields of grain vary from 0 to 200 pounds per acre-inch of rainfall. Thus, irrigation may more than double the efficiency of water use.

Irrigation systems should not be set up unless the increased income will exceed the additional cost of land leveling and the cost of obtaining the water. Dryland management practices, using wide rows and low seeding rates, may be more efficient in some areas.

Consult your Soil Conservation Service specialists or county agents in developing your irrigation system, in preparing your field for irrigation, and in managing your water for irrigation.

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Irrigating GRAIN SORGHUMS

By M. E. Jensen and J. T. Musick, agricultural engineers, Soil and Water Conservation Research Division, Agricultural Research Service

Irrigated grain sorghum is a major crop in the Great Plains and some irrigated valleys of the West. In the southern Great Plains of Texas and Kansas more than 2,000,000 acres of sorghum are under irrigation. Grain sorghum may yield 7,000 to 8,000 pounds per acre with adequate moisture and fertility.

EFFECT OF DEFICIENT SOIL MOISTURE ON PLANT GROWTH

Wilting, rolling, and twisting of plant leaves are the first recognized symptoms of deficient soil moisture. A severe or a prolonged drought period may cause firing of the leaves and stunted plant growth (figs. 1 and 2).

Nitrogen deficiency may also cause firing of leaves and decrease grain yields. Nitrogen deficiency symptoms occur first on the lower leaves and yellows the leaf. Deficient soil moisture symptoms occur first on the new leaves and are noticeable

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Figure 1.—This plot of grain sorghum at Bushland, Tex., was irrigated only before planting. Severe soil moisture deficiency caused stunted growth, small heads, and firing of the leaves.

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Figure 2.—This plot of grain sorghum at Bushland was irrigated before planting and 1 week before the boot stage. Soil moisture was deficient and resulted in spindly stalks and small heads that decreased grain yields 45 percent from optimum moisture conditions.

before heading. After heading, moisture deficiency symptoms are not so readily apparent.

Early in the crop season grain sorghums have a remarkable ability to recover from the effects of deficient soil moisture. But irrigation that ends severe soil moisture deficit before heading of the sorghum may stimulate undesirable sucker growth.

Lack of soil moisture later in the season usually does not affect plant height but causes spindly stalks with smaller and fewer heads of grain and many unfilled grains in the heads. Also, these plants are more susceptible to lodging. In one instance of moisture stress, grain yields were decreased by 45 percent.

Ample soil moisture supplied by rainfall or irrigation benefits the crop most before it reaches the dough stage of grain. After the hard-dough stage, added soil moisture will not increase grain yields.

WATER USE BY SORGHUM

Sorghum plants normally extract about 40 percent of their water requirements from the top quarter of the root zone. Rainfall will increase the proportion of water used from shallow depths.

A study at Garden City, Kans., showed that sorghum will begin to decrease in yield when two-thirds to three-fourths of the available soil moisture is used from the soil depth explored by the plant roots. Available soil moisture is moisture available to plants between field ca-

pacity (the moisture content 2 to 3 days after a heavy irrigation or several heavy rains) and the permanent wilting moisture content (when plants will not recover from wilting).

When grown in deep permeable soils, roots of mature plants penetrate to a depth of 4 to 6 feet, but the roots penetrate only 1 to 2 feet during the first few weeks of plant growth. Roots continue to develop in depth and density as the plant matures. At the same time, the volume of soil moisture available to the plant roots also increases.

To produce high yields, grain sorghums will need 22 to 24 inches of water in the southern Great Plains and 23 to 25 inches in the Southwest. The rate of water use increases gradually with increasing plant growth and ground cover. The peak water use measured in a study in the southern Great Plains occurred at the boot-to-flowering stage of plant development (fig. 3). The peak use in the Southwest occurred at the flowering-through-early grain stage of development (fig. 4).

The rate of water use gradually declines after the grain-development stage. Plant maturity and less solar radiation slow water use. In a short growing season, water use will almost stop at the first killing frost.

In the southern Great Plains, an appreciable part of the 22 to 24 inches of water is contributed by rainfall. Normally, to obtain high yields you will need to supply approximately 8 inches of irrigation water in subhumid areas, 8 to 16 inches in semiarid areas, and more than 16 inches in arid areas.

IRRIGATION REQUIREMENTS AND SCHEDULES

All the water pumped or delivered to the farm will not be stored in the soil for crop use. Some water is lost through seepage and evaporation from ditches, percolation below the crop root zone, and

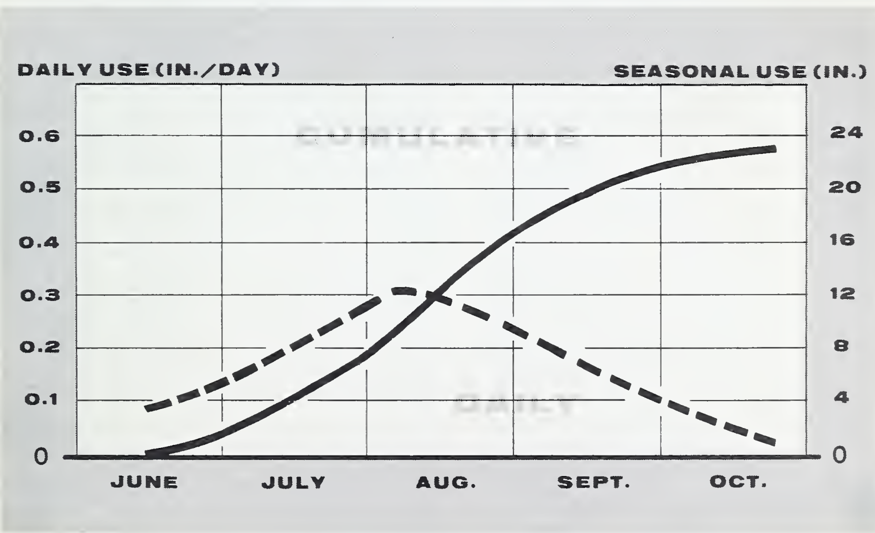

Figure 3.—Water use by irrigated grain sorghum in the southern Great Plains at Bushland, Tex., and Garden City, Kans. Stage of plant development: Emergence, mid-June; rapid elongation, late July; late booting, early August; flowering, mid-August; grain development, late August to early September; complete maturity, October.

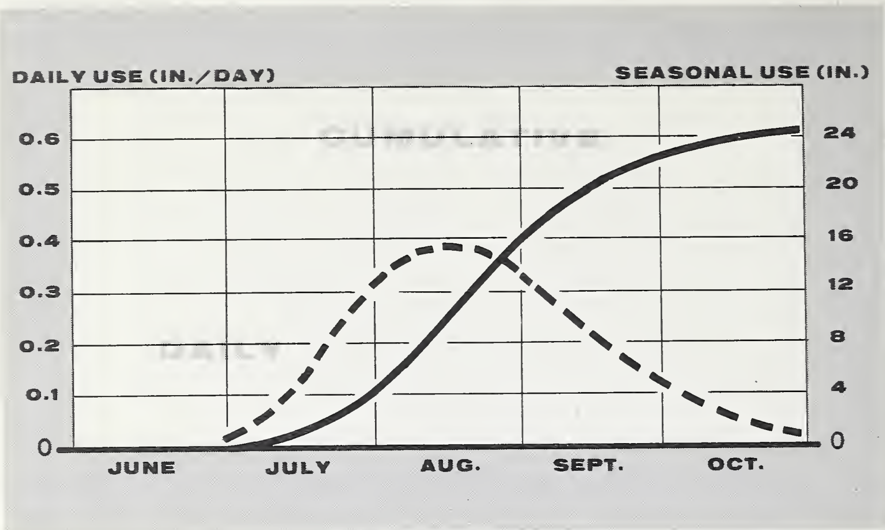

Figure 4.—Water use by irrigated grain sorghum in the Southwest at Mesa, Ariz. Stage of plant development: Emergence, early July; rapid elongation, late July; late booting, early August; flowering, mid-August; grain development, late August to early September; complete maturity, October.

runoff from the field. The irrigation water requirement includes these losses in supplying the water for each schedule.

The quantity of water a given soil holds and that is available to plants depends on the soil texture (size of particles, as coarse, medium, or fine) and its depth. Soil moisture for each foot of soil depth is available to plants in the following approximate quantities:

For coarse-textured (sandy) soils	0.75 to 1.25 inches;
For medium-textured (loam) soils	1.25 to 1.75 inches;
For fine-textured (clay) soils	1.75 to 2.25 inches.

These values indicate not only the maximum water that plants can remove but also the maximum requirements for irrigation water per foot of soil to replace the water removed by the crop.

Sandy or shallow soils with limited storage and clay soils that have low water-intake rates will require more frequent irrigations than deep permeable soils.

If sufficient irrigation water is available to provide for maximum yields, the following schedule is recommended. To begin the growing season with a good soil moisture supply, a preplanting irrigation is desirable. Apply it early in spring when water is not needed to irrigate other crops or just before planting the sorghum. It should wet the soil to rooting depth, which is 4 to 6 feet in deep, permeable soils.

When the crop has used 50 to 60 percent of the available soil moisture in the root zone, apply other irrigations during the growing season—usually one to four. Time for irrigations is determined either by use of soil moisture instruments, by taking soil samples, by stage of plant growth, or by keeping a record of water use and moisture supplied.

Keeping a record.—For a record system, Soil Conservation Service technicians or the county agent can supply the available soil moisture values for a certain soil. Figures 3 and 4 can supply the average rate of daily use of the moisture by the

plants in typical weather for the area.

For example, after a soil is filled with moisture to field capacity (either by rainfall or irrigation), you determine that the crop will need an irrigation after 4 inches of soil water is used in the root zone. The crop is using 0.20 inch of water each day. At this rate the next irrigation would be scheduled in 20 days. However, 1 inch of rainfall occurred in this period. As a result you can delay the irrigation 5 days, or 25 days from time of field capacity.

Checking soil moisture.—Tensiometers and electrical resistance moisture blocks are available for use as a guide to indicate when to irrigate. The tensiometers indicate the force that must be exerted to remove water from a soil. They consist of a porous ceramic cup, a vacuum gage, and a water-filled connecting tube. The porous cup is placed in the root zone of the crop. As the soil becomes dry a higher reading is shown on the dial. Some gages may only indicate a wet, medium, or dry condition. Tensiometers are best suited for use in sandy soils.

Electrical resistance blocks indicate the amount of moisture in the soil indirectly. As the soil becomes dry, the block (generally made of plaster of paris) also dries. The resistance to flow of a small electrical current between two electrodes within the block is greater when the block is dry than when the block is wet. Thus, by measuring the resistance with a small instrument, an indication of the available soil moisture is easily obtained. Most instruments are calibrated so that they indicate the approximate percentage of available moisture in the soil directly. Electrical resistance blocks work best in fine-textured soils that do not contain very much soluble salts.

Both tensiometers and electrical resistance blocks should be placed at two depths—such as 12 and 30 inches—and at two or three locations in the field. Operating instructions are generally given by the manufacturer.

If you plan to irrigate when available soil moisture is depleted 50 percent or more, check by observation the soil moisture periodically to rooting depth. Augers, tubes, or other equipment are used to obtain the samples. With experience on a certain soil, though less exact, you can estimate the approximate amount of available soil moisture by the appearance of the soil. Soil Conservation Service technicians or the county agent can supply the information needed to estimate available soil moisture for soils in your area.

Stage of plant growth.—It may be difficult to sample and interpret the available moisture in the soil in order to time the irrigations during the growing season. Then, you may schedule the irrigations by the stage of plant growth. If rainfall is normal, the following irrigations will usually supply the water requirements: Apply the first irrigation about 3 to 5 weeks after planting, when the plants are 10 to 20 inches high; apply the second at the boot-to-flowering stage; and the third during grain development.

If the crop is making adequate growth early in the season and water is available for only one irrigation after the preplanting irrigation, apply this irrigation when the sorghum is near the boot stage of growth. However, you cannot expect optimum yields in the Great Plains if only one irrigation is applied.

If the water supply is limited and the average rainfall is 5 to 10 inches during the growing season, apply only a preplanting irrigation that wets the soil to a depth of 5 to 7 feet on some of the land. Use dry-

land planting rates and cultural practices on this land. Then the limited water can be used on the remaining area where irrigated planting rates and adequate fertilizer can be provided.

IRRIGATION AND MANAGEMENT PRACTICES

Good management practices are necessary for high yields and efficient production. Sufficient water and a good irrigation system will not produce optimum yields unless good cultural practices are followed and sufficient fertilizer is added.

Plant adapted hybrids of grain sorghum at the rate of 4 to 8 pounds per acre when the soil temperature at seeding depth is 65° to 70° F. If sufficient water will be available during the season and adequate fertilizer is used, plant the crop in narrow rows of 12 to 20 inches to obtain maximum yields. However, special equipment may be required and weed control may be more difficult. If soil moisture may be limited at some time during the growing season, plant at the rate of 2 to 4 pounds in wide rows of 30 to 40 inches. Control weeds by chemicals or cultivation. Keep diseases under control by choosing varieties that are resistant to diseases.

Nitrogen is the principal fertilizer element that limits grain sorghum yields—it may be necessary to apply 60 to 180 pounds per acre. Some soils may require phosphorus. In a few areas iron applications are required to control chlorosis. Your local county agent or Soil Conservation Office can supply information on the fertilizer requirements for your area and the recommended varieties to plant.

The underground concrete pipe and portable aluminum gated pipe for an irrigation system is frequently used with graded furrows and border strips in the southern Great Plains. This irrigation system eliminates ditch water losses. The graded furrows between rows of sorghum act as channels to conduct water. On some soils every other furrow is irrigated. To obtain uniform distribution of water storage along the furrow, apply the water so that it reaches the end of the field in one-fourth to one-half the time required for the irrigation.

Graded border strips conduct water uniformly over the soil surface to the end of the field from an irrigation head ditch or gated pipe. The water is contained within border strips by narrow ridges, usually about 50 feet apart.

Some irrigation systems use level benches for the distribution of irrigation water within the fields. These benches hold rainfall that would run off sloping land, owing to high rainfall intensities and low intake rates of some soils.

Plan the irrigation system so that it minimizes water losses from ditch seepage, deep percolation below the root zone that occurs when long runs are used, and runoff losses. Your Soil Conservation Service technicians can help you build a system that can be managed efficiently.

Plan to irrigate before the crop shows symptoms of soil moisture deficiency; that is, before 50 to 60 percent of the available soil moisture in the root zone has been used (see pp. 2 to 3). Plant appearance is a poor indicator of the time to irrigate. Plants do not show the need for water soon enough to schedule an irrigation that will require several days to complete.

Although most methods of scheduling irrigations start when less than 60 percent of the available soil moisture is used, start irrigating earlier if several days are needed to complete the operation.

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